

New Accuracy Levels for Solar System Ephemerides

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The JPL Planetary and Lunar Ephemerides, DE402/LE402, represent a number of changes and improvements to previous JPL ephemerides: the reference frame is now that of the IERS, newer and more accurate observations are used in the adjustment process, some of the data reduction techniques have been refined, and improved dynamical modeling has been incorporated into the equations of motion.

A frame-tie determination between previous JPL ephemerides and existing radio source catalogues was used to orient DE402/LE402 onto the IERS Reference Frame with an accuracy of only 3-4 milliseconds. Recent radar-ranging observations to Mercury, Venus, and Mars have been acquired; the set of Viking Lander ranges is complete; VLA thermal emission measurements of the Jovian planets and VLBI measurements of the Magellan, Phobos, and Ulysses spacecraft have been added to the data set; the tracking files of the Voyager and Pioneer encounters of Jupiter have been re-reduced; the set of transit observations has been extended, including photoelectric transit measurements of Pluto; and Lunar Laser Ranging observations up to the present are included. The surfaces of Mercury and Venus are modeled more accurately, the perturbations of 300 asteroids are accounted for, and the formulation for integrating the lunar libations has been improved.

The internal accuracy of the inner four planets continues to improve. Moreover, the orientation of that system has been accurately established for the first time with respect to an external reference frame. Various measurements accurately tie Jupiter into the inner system. In the future, use of CCD measurements and the Hipparcos Catalogue should improve the ephemerides of the outermost four planets.